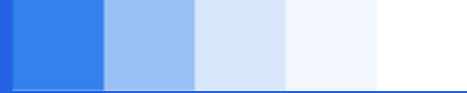# Roadmap for Operational Wave Modelling at the Bureau of Meteorology

Stefan Zieger – Research Program

Outline

- Modelling strategy
  - Australian Parallel Suite Upgrades
  - UKMO-Bureau model development program
  - APS4

- Ensemble verification
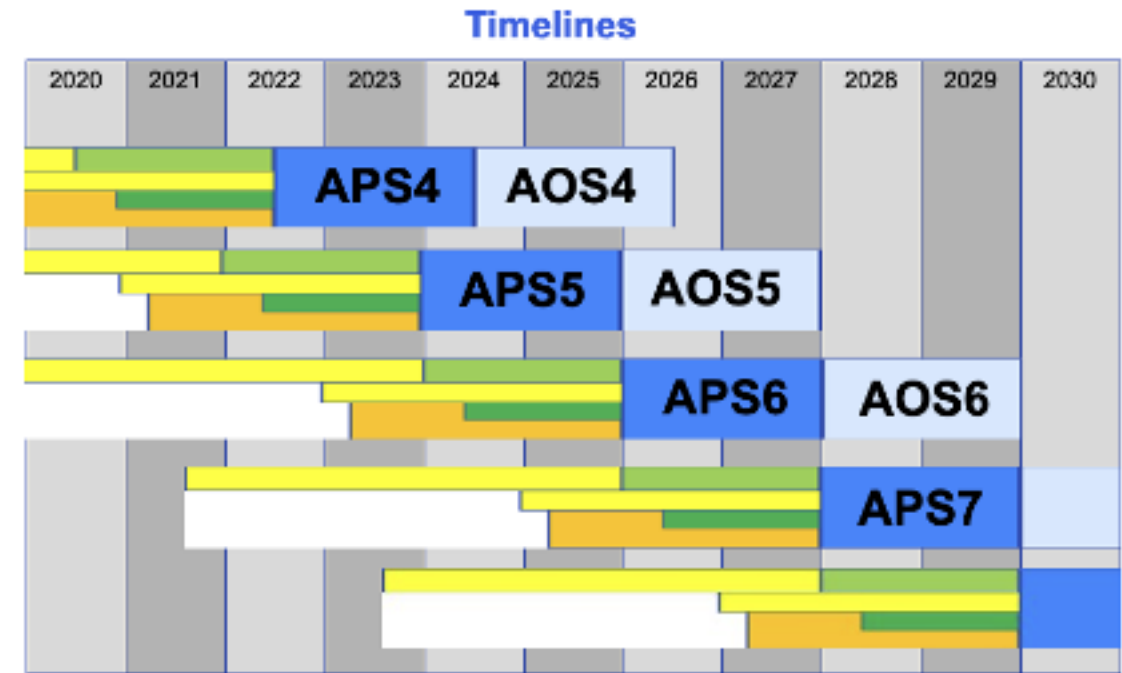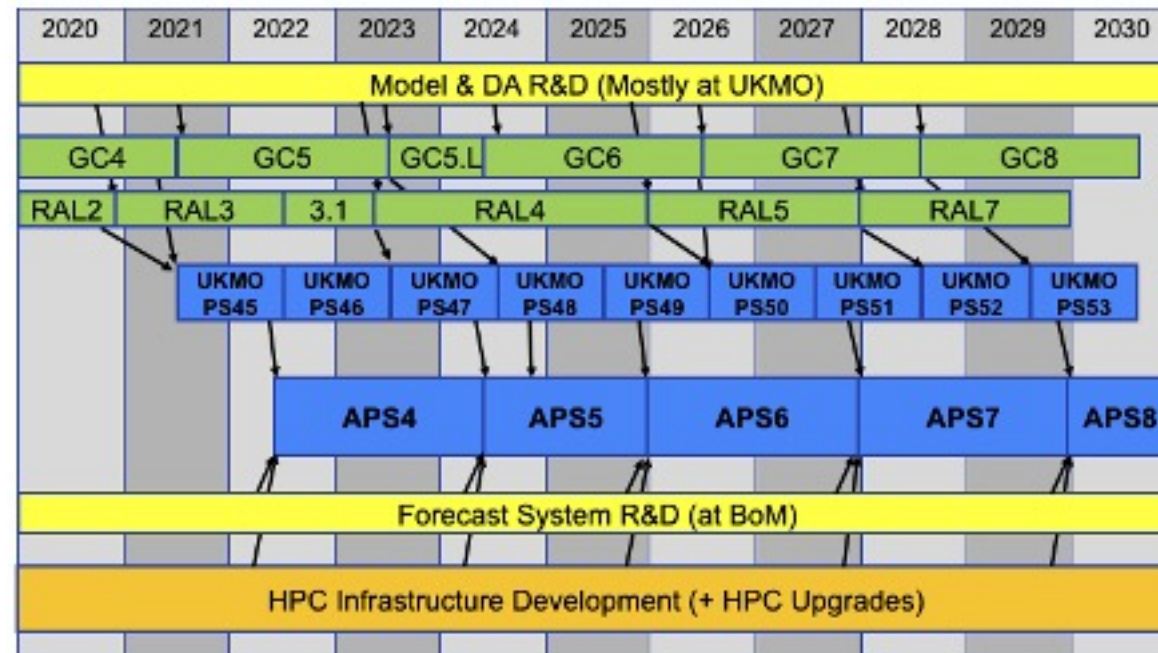 - ACCESS/AUSWAVE-GE4

Modelling Strategy

Australian Parallel Suite Cycles

- In the APS cycle all modelling systems and infrastructure are upgraded at the same time.

- Initial proposition was that at the Bureau this is done every 2 years.
  - Global, regional, ensemble weather models
  - OceanMAPS, ocean analysis
  - Seasonal system
  - Storm surge
  - Land surface
  - Global wave model (since APS3), wave ensemble (APS4)

Timelines

| 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |

APS4 · AOS4
APS5 · AOS5
APS6 · AOS6
APS7

UKMO-Bureau model development program

- Model and data assimilation R&D is done in collaboration with UKMO partnership program.
  - Global, regional coupled model configuration every 2 years
- Forecast system R&D is specific to the Bureau
- Working upstream with the UKMO to ensure that improvements important to Australia are implemented in each model configuration release.

Objective

Key performance indicator(s)
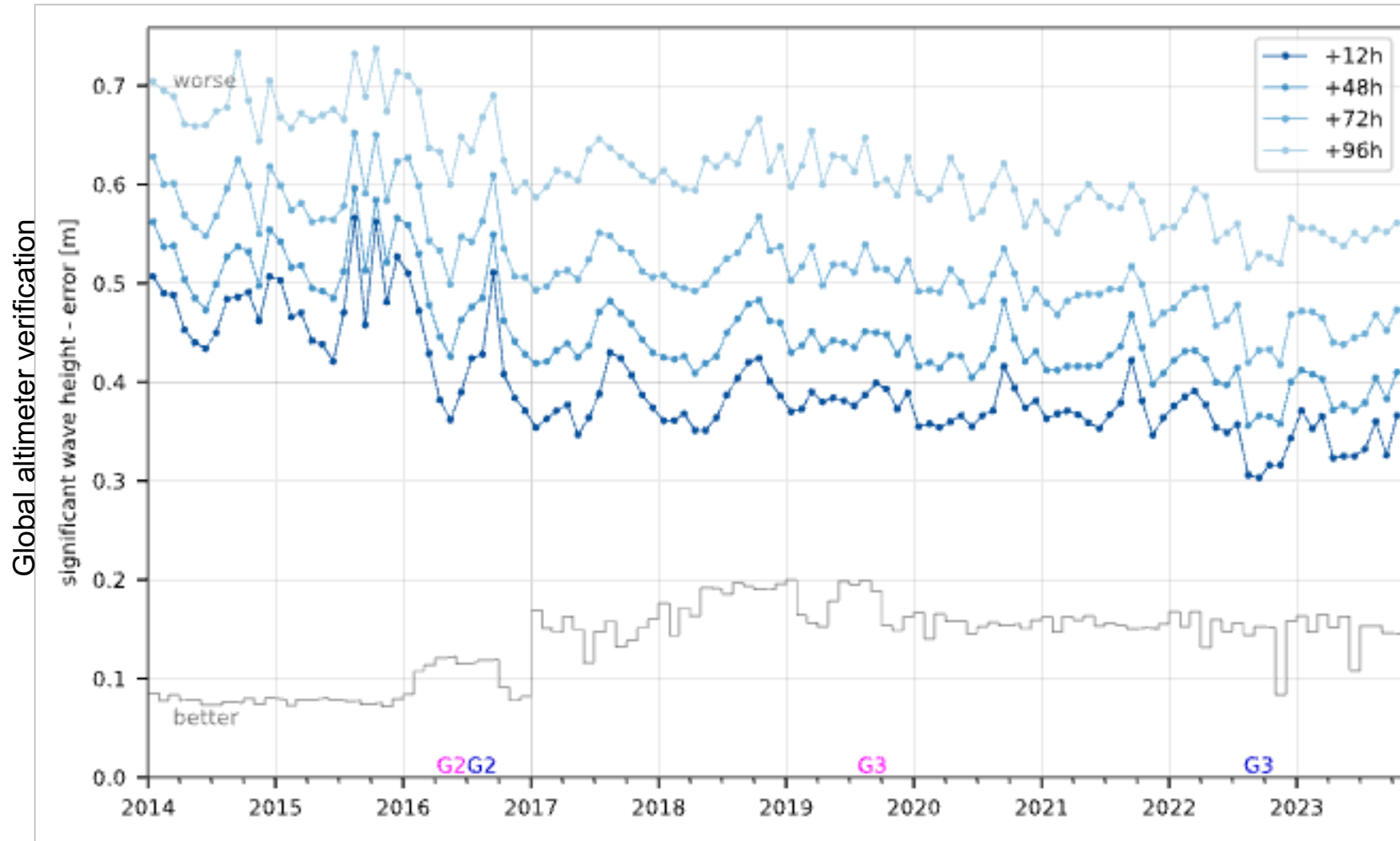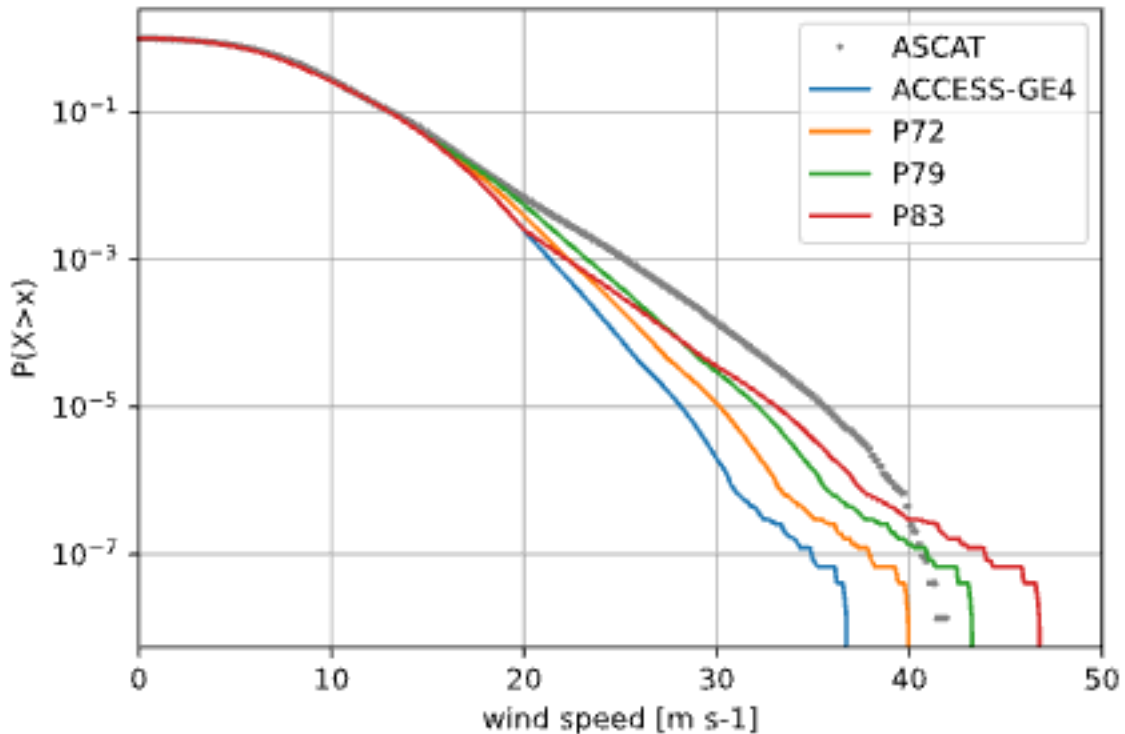

Target
Being under the
top 5 international
models in terms of
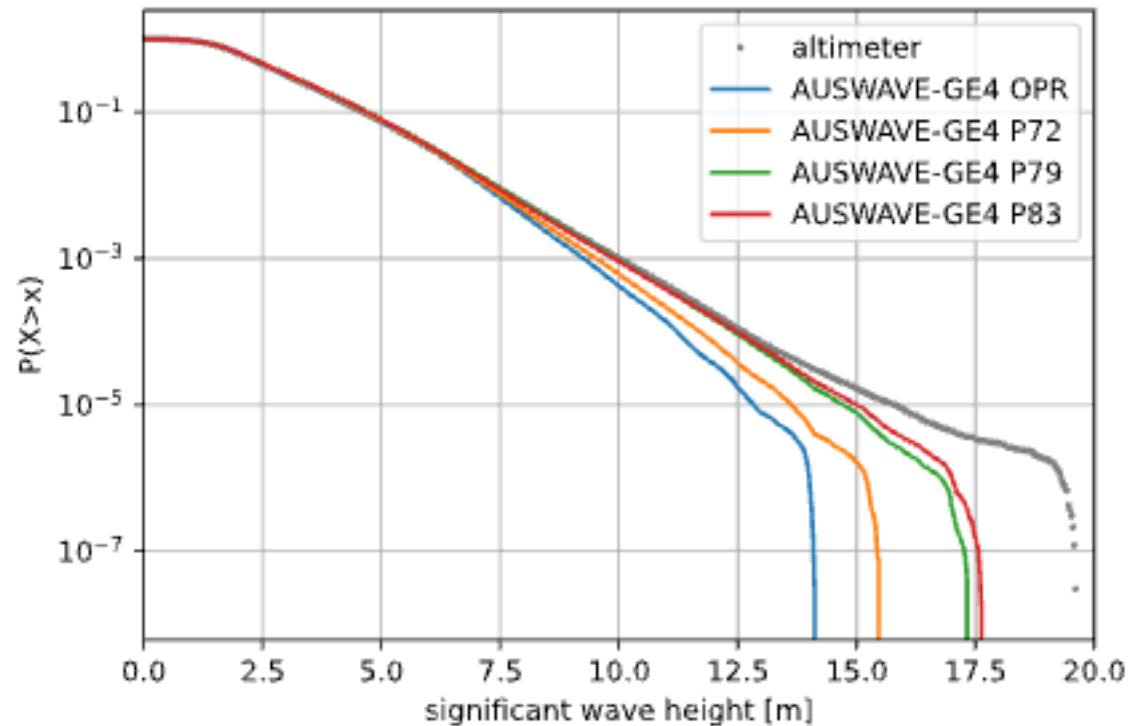skill performance.

Australian Parallel Suite

4th generation (APS4)

- Global wave model (AUSWAVE-G4)
  - Dependencies:
    ACCESS-G and OceanMAPS4.1
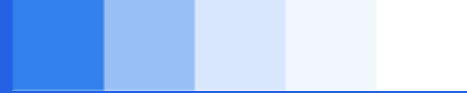
- Global wave ensemble (AUSWAVE-GE4)
  - Dependencies: ACCESS-GE

Extreme surface winds are biased low
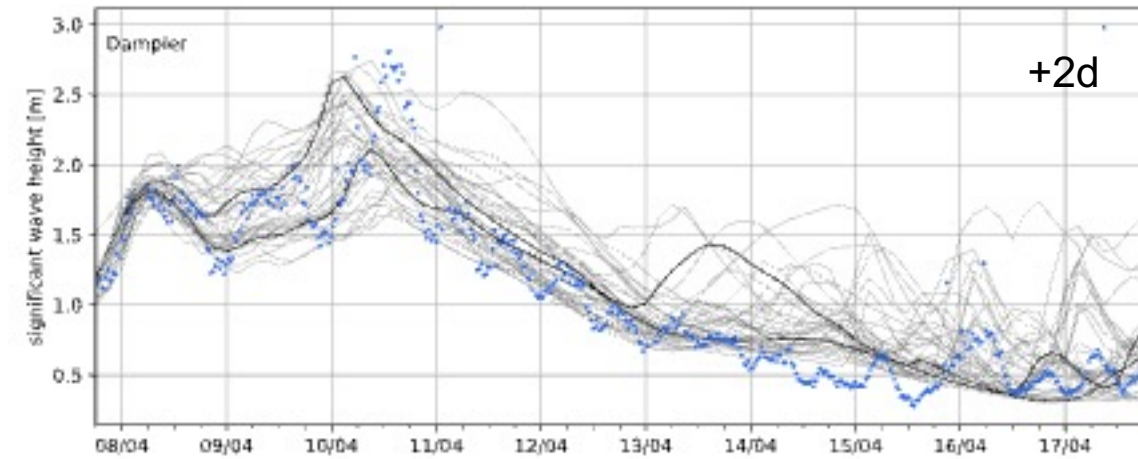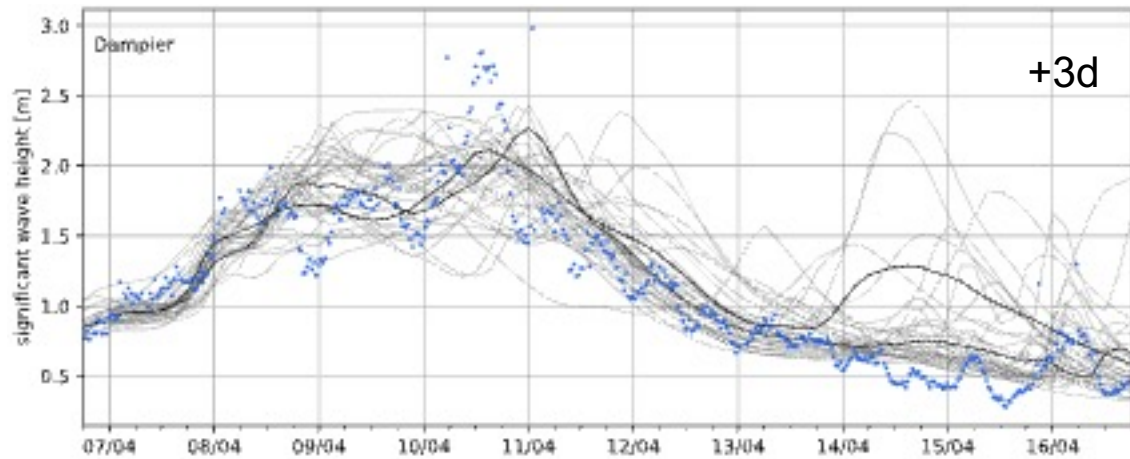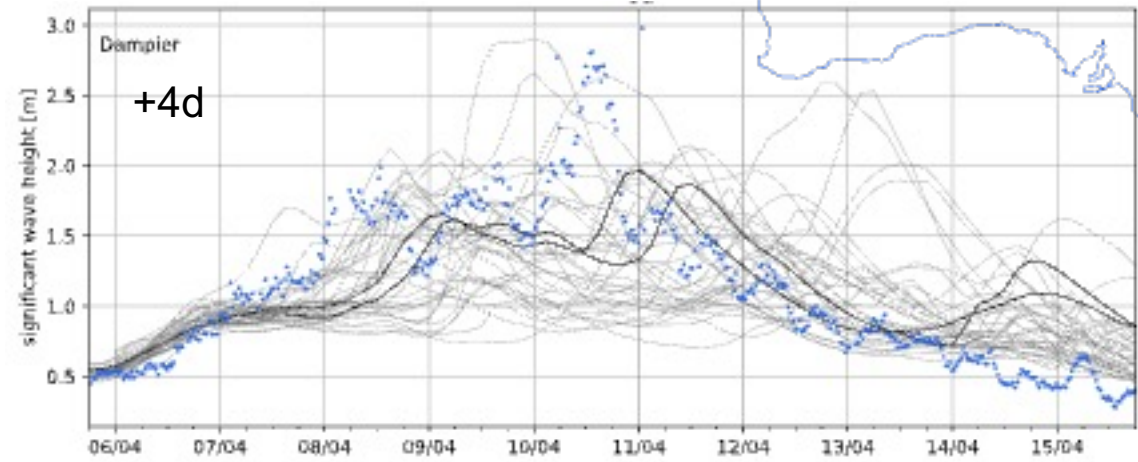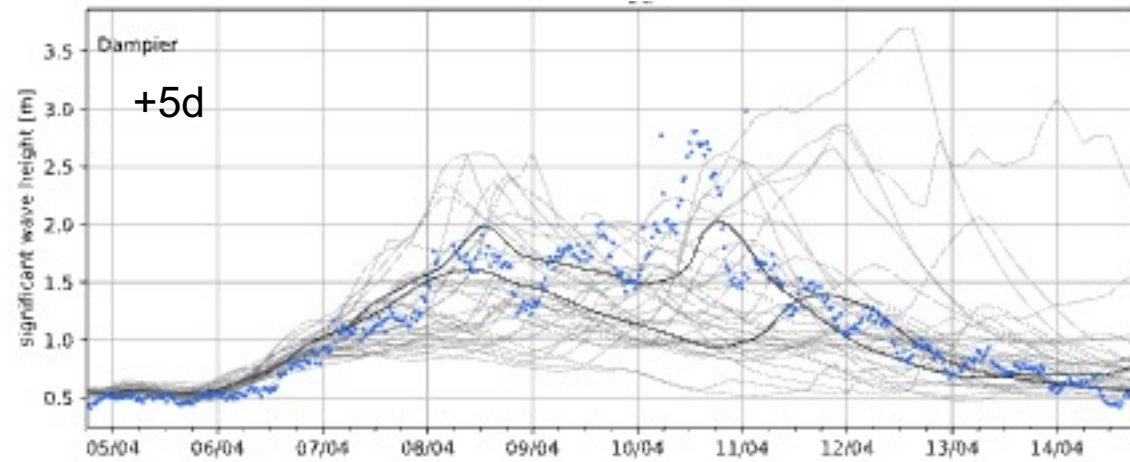
Extreme wave heights are biased low

Ensemble verification

Ensemble verification
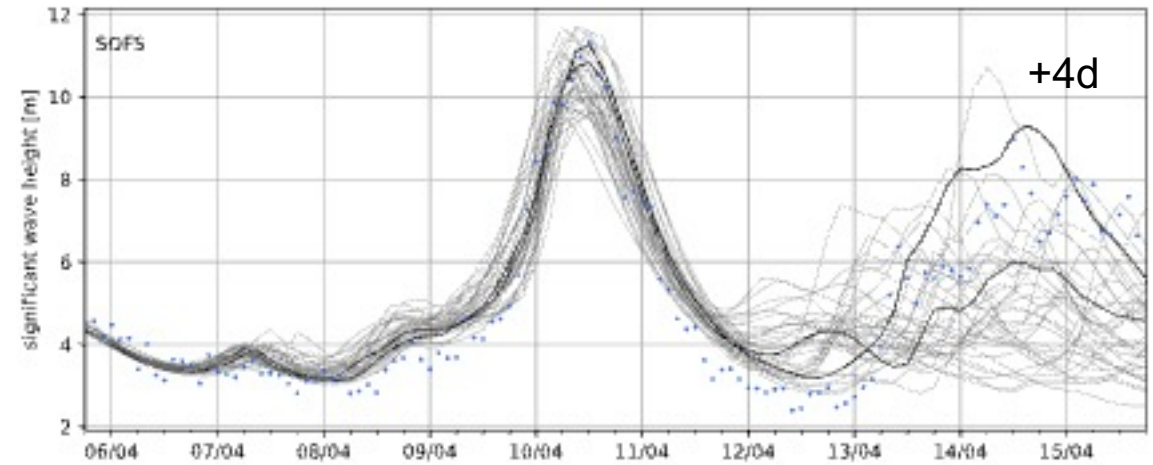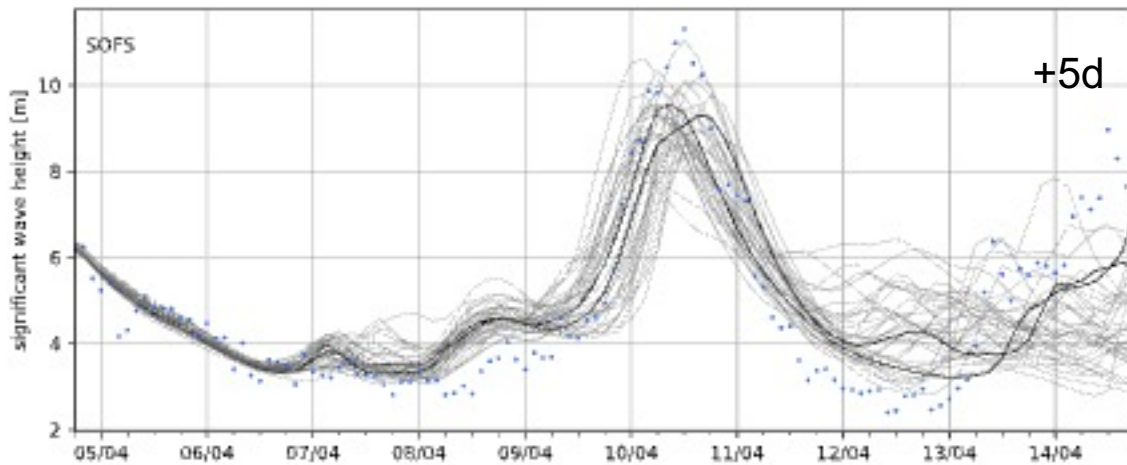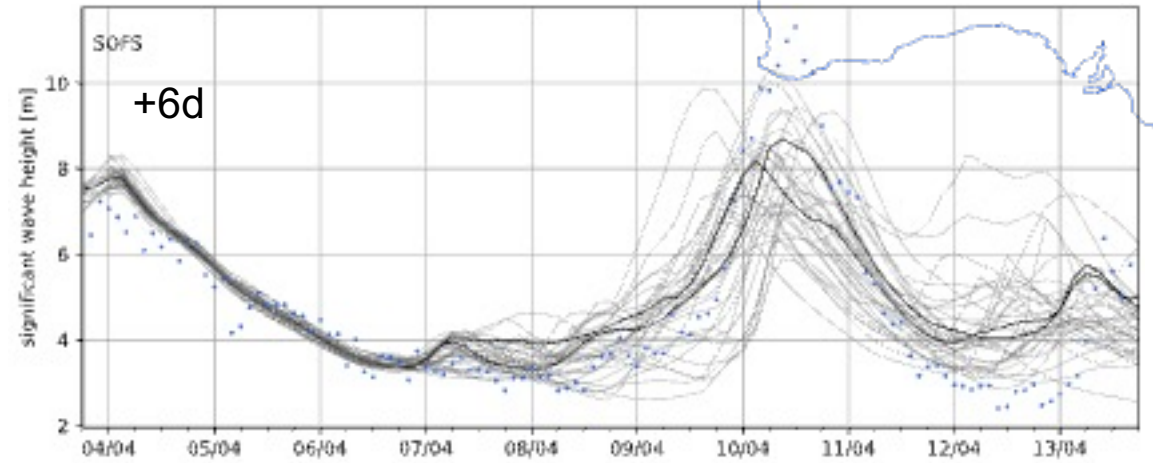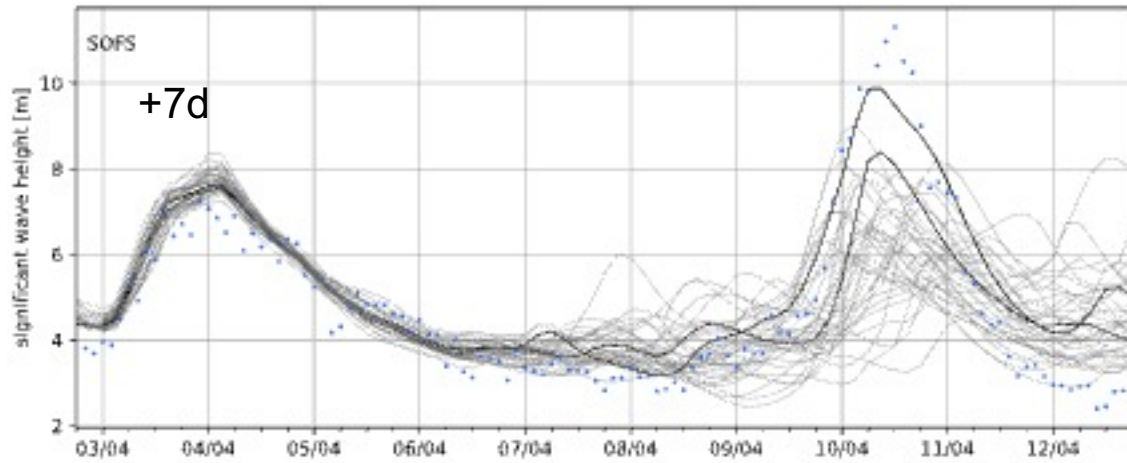
Dampier

116.52°E 20.48°S

Ensemble verification

Southern Ocean Flux station 141.87E 46.73S

141.87°E 46.73°S

Ensemble verification

Spread-skill diagram

- Measure of the quality of the ensemble system.

- Underlying hypothesis is exchangeability between a random variable represented by the ensemble member and the observation.

- In a perfect ensemble, any member could be exchanged with the verifying observation at any forecast time, so that one could not distinguish ensemble forecast from observation, without increasing the error estimate and changing the joint distribution of the ensemble members.

- Skill (root-mean-square error) is equivalent to the sum of squared bias and variance of the biases.

Continuous Ranked Probability Score

- The continuous ranked probability score (CRPS) is a scoring rule that is popular for assessing the quality of ensemble forecasts. It is a quadratic measure of the difference between the forecast cumulative distribution function (CDF) and the empirical CDF of the observation.
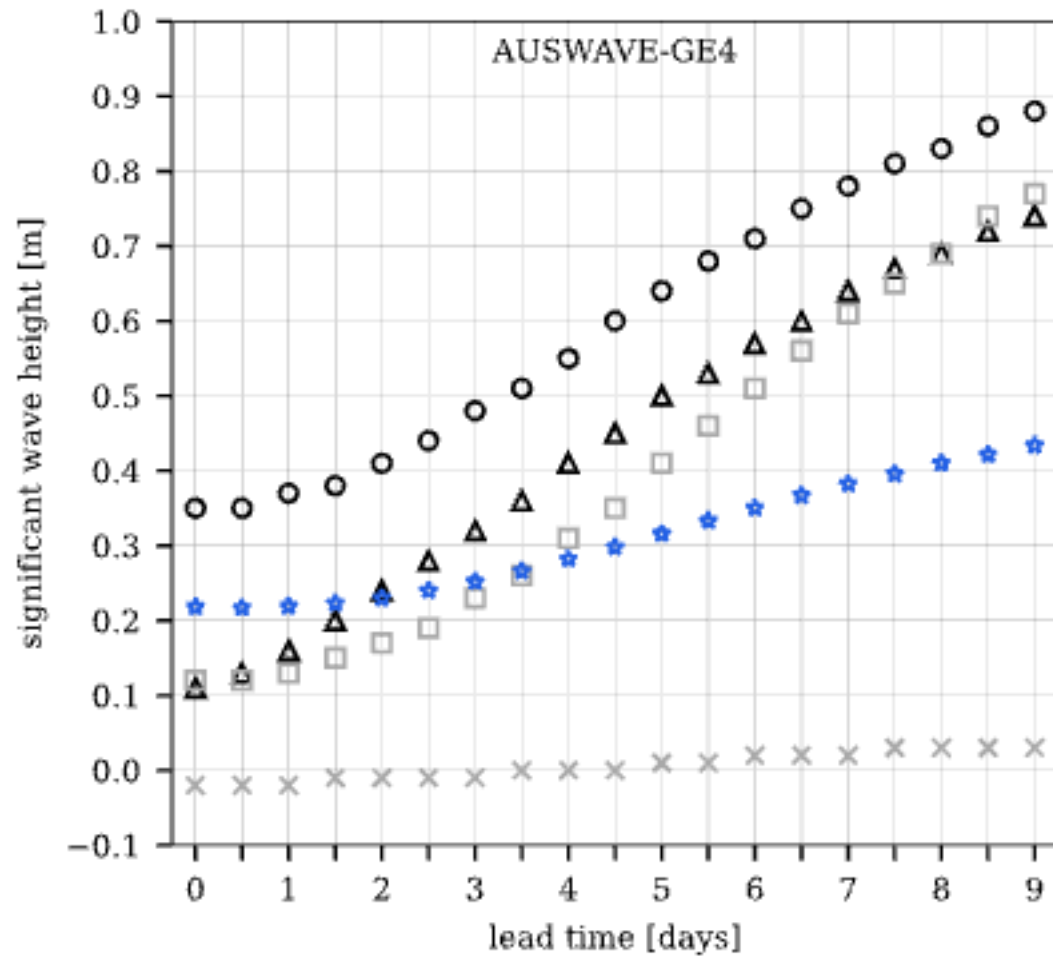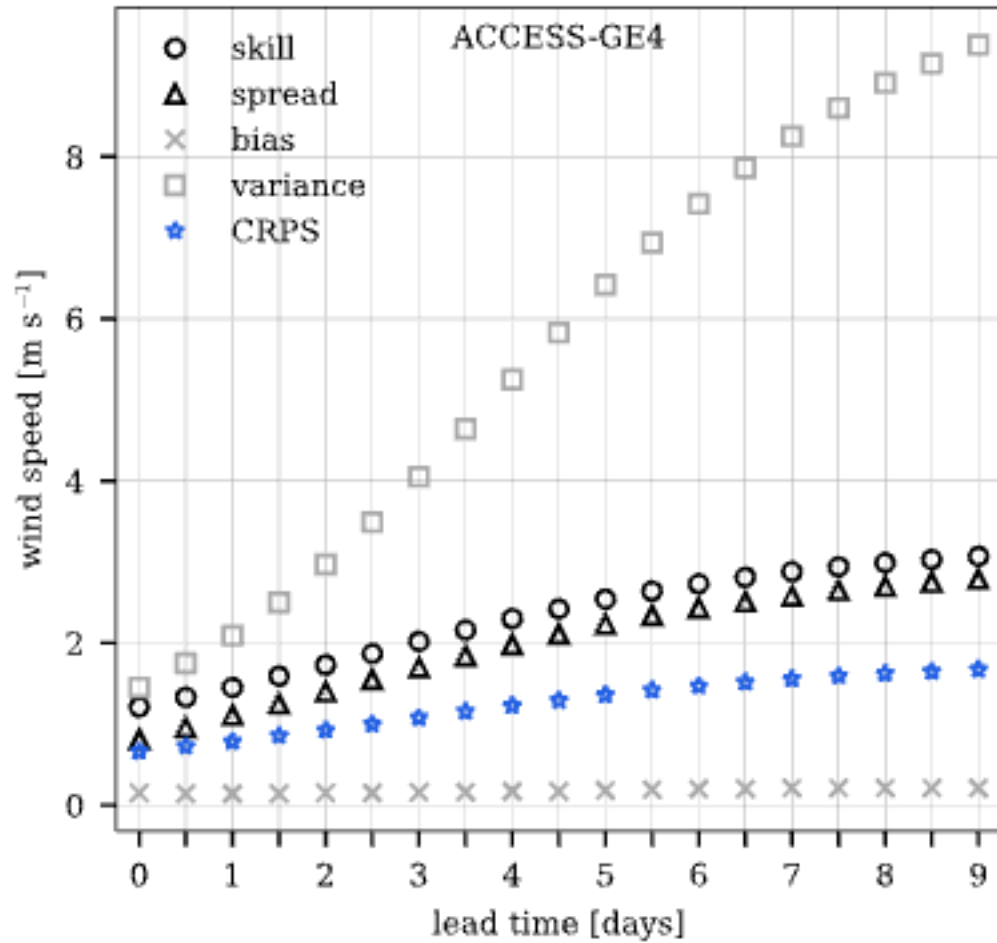
Reliability diagram

- Reliability diagrams measure the quality of probabilistic forecasts and assesses the difference between predicted probabilities and the observed frequency.
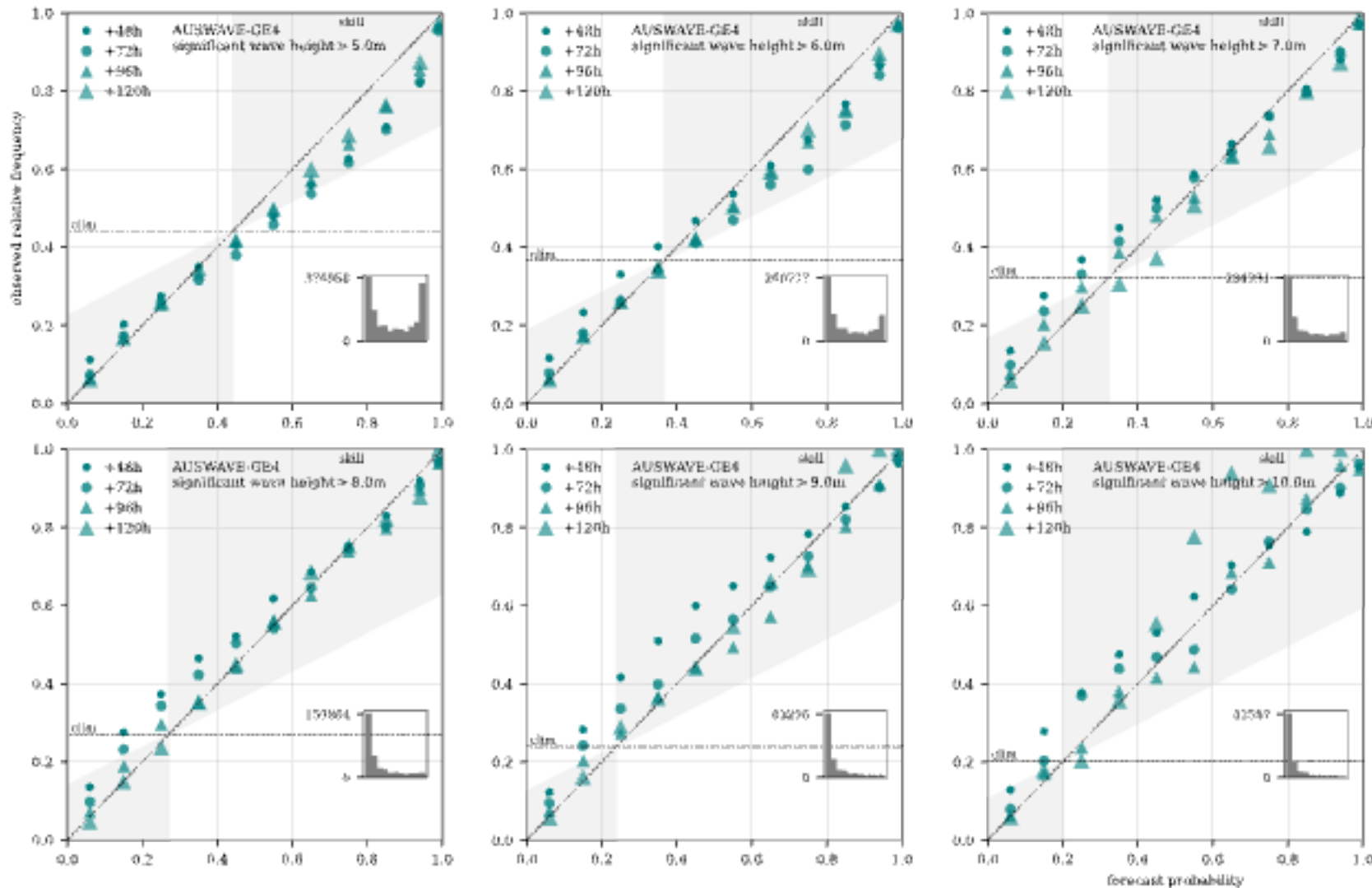
Ensemble verification

Spread-skill diagrams for Feb-Nov 2021

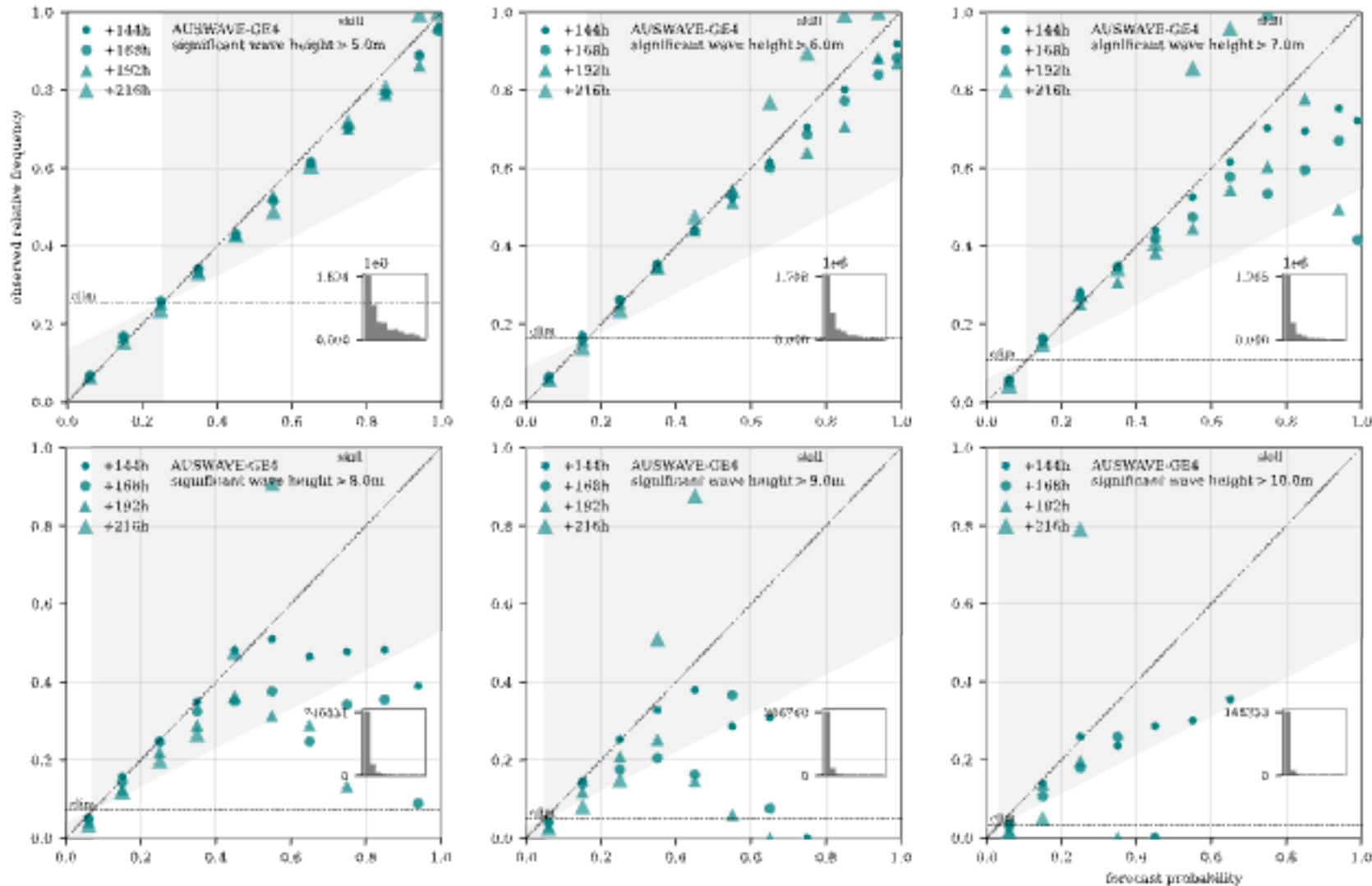# Ensemble verification

Reliability diagrams for Feb-Nov 2021

- Global altimeter (Young & Ribal 2022)

- **2 to 5 day** forecast range

- Hs > 5,…., Hs > 10 m

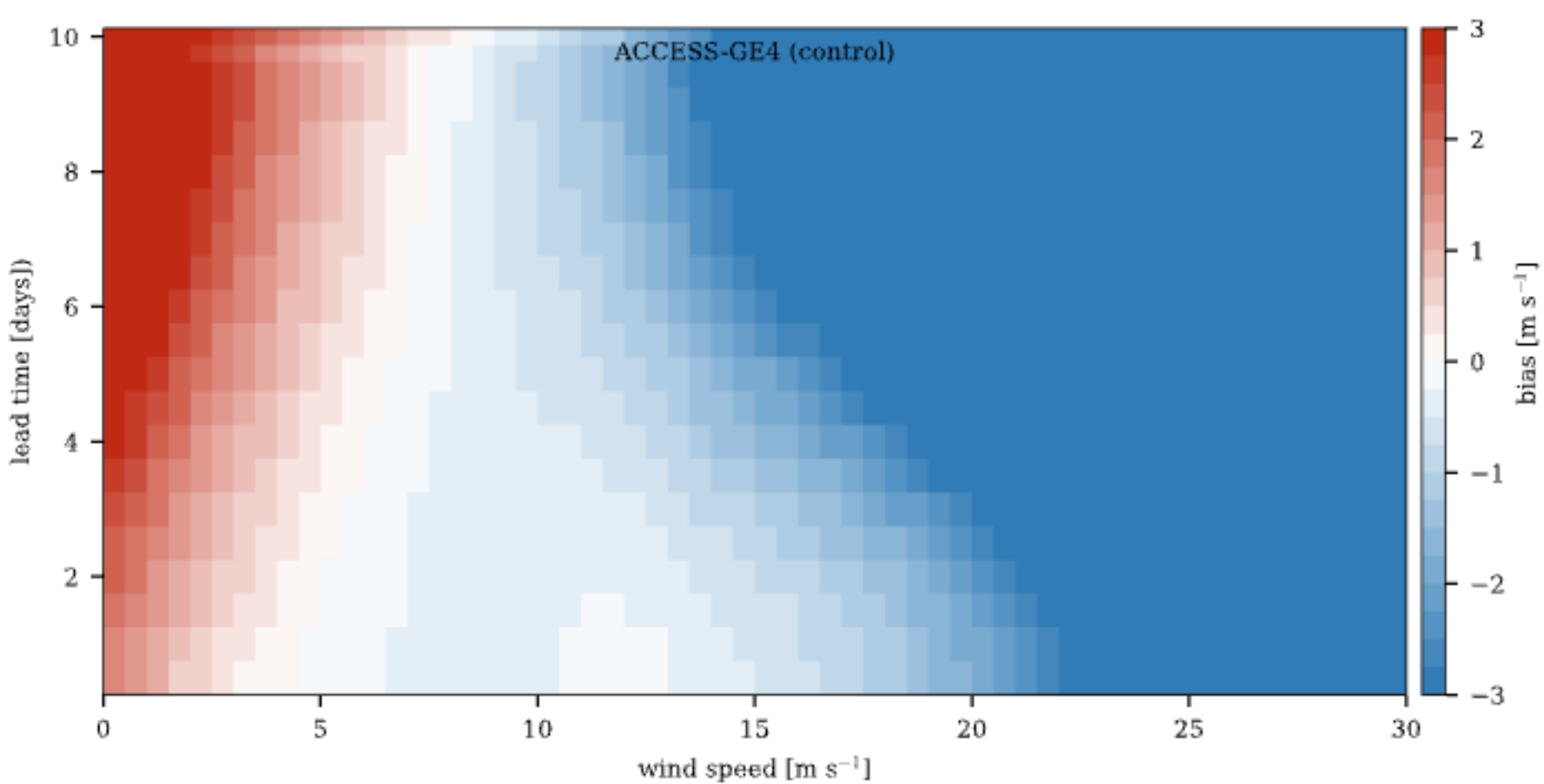# Ensemble verification

Reliability diagrams for Feb-Nov 2021

- Global altimeter (Young & Ribal 2022)
- **6 to 9 day** forecast range
- Hs > 5,…., Hs > 10 m

Ensemble verification

Surface wind bias for Feb-Nov 2021

ACCESS-GE4 (control)

- Global scatterometer (ASCAT)
- **1/2 to 10 day** forecast range
- Control member

Questions?

stefan.zieger@bom.gov.au